OPERATING INSTRUCTIONS

MODEL TN 33 TEST HYBRID

NORTHEAST ELECTRONICS CORPORATION
AIRPORT ROAD
P. O. BOX 425 CONCORD, N. H. AREA CODE 603 224-7466

RETURN TO!
FILE FOLDER
L-1106
F. MACCHIA.

MODEL TN 33
TEST HYBRID

Table of Contents

Section	Title	Page
	Front Panel View, Figure 1	
1.0	General	1.1-1.2
2.0	Performance Data	2.1-2.2
3.0	Circuit Description	3.1
4.0	Controls, Jacks and Terminals	4.1
5.0	Calibration	5.1
6.0	Operation	6.1
7.0	Maintenance	7.1

Figures 2 - 18

Table of Replaceable Parts

List of Manufacturers Code Letters for Replaceable Parts Table

NOTE: "The information contained in this manual is the property of Northeast Electronics Corporation and may not be reproduced or used for manufacturing purposes except by written permission from Northeast Electronics Corporation".

ISSUED October 1966
PRINTED IN USA

LINE SL
REC 4-W OUT
4-W OUT
241
310
OUTPUT FILTER
HIGH PASS
NONE
LOW PASS
LINE IMP (n)
600
900
1500
LINE
241
310
LINE NET CAP (μF)
1.08
2.16
4.32
4-W IN
241
310
FUNCTION
CAL HYB LOSS MEASURE
HYB CHECK
4-W =SND IN
CH GND
X.01μF
BUILDOUT
X.001μF
NETWORK AND BUILDOUT
NETWORKS AND BUILDOUT DECADE DISCONNECTED FROM HYBRID CIRCUIT FOR EXTERNAL USE
NORTHEAST ELECTRONICS CORPORATION
CONCORD, N.H. U.S.A.
APPROX BUILDOUT REQUIRED FOR .5 END-SECTION
NETWORK
CAP (μF)
H-88 .030
D-88 .022
D-66 NONE
NOMINAL CABLE CAP=.083 μF/MI
MODEL TD-33 TEL HYBRID
D-88 (.18 END-SECT)
NON LOADED
+2.16 μF
H-88 (.18 END-SECT)
600n
900n
1300n
EXT NET
NETWORK SELECTOR
LINE
EXT NET

FIG. 1

MODEL TN 33

TEST HYBRID

Operating Instructions

1.0 GENERAL

1.01 The Model TN 33 is a portable test hybrid useful in the performance of a variety of balance measurements. The unit contains two NEC TN 44 special transformers, precision balance networks, network-buildout decades, a low-pass and a high-pass filter. The various circuit arrangements are selected by means of keys and rotary switches. All points of the circuit are accessible at jacks and terminals.

1.02 Three modes of operation are selected by the FUNCTION key switch.

MEASURE: This switch position is used in measuring the balance of a circuit under test. In this position other switches permit the connection of one of the internal networks, an external network and/or the buildout decades to the hybrid "network" branch.

HYBRID CHECK: In this switch position, matched 600Ω resistors are substituted for the network and the external line termination to check the basic input-to-output (transhybrid) balance of the set.

CALIBRATE HYBRID LOSS: In this switch position a short circuit is applied across the line branch while retaining the selected network; this permits measurement of the hybrid insertion loss.

1.03 By means of the LINE IMP key switch, matching to lines having a characteristic impedance of 600, 900 or 1500Ω is provided. A 600Ω nominal impedance is maintained at the 4-W IN and 4-W OUT terminals for each of the three switch positions.

1.04 Precision networks covering the most common H-88, D-88, D-66 and non-loaded facilities, 600, 900 and 1500Ω compromise terminations, a 600Ω resistor, and a set of terminals to connect an external network are selected by a rotary NETWORK SELECTOR switch. Setting the FUNCTION switch to HYB CHECK disconnects the network circuits from the hybrid transformers. In this position the NETWORK terminals, which are connected to the NETWORK SELECTOR switch arms, permit use of the networks in external circuits.

1.05 Two buildout capacitance decades, covering the range from 0 to .11μf, are connected in parallel with the networks. These also permit using the TN 33 Hybrid set as a direct reading capacity bridge. Additional capacity may be connected to the NETWORK BUILDOUT terminals as required.

1.06 A choice of three different capacitors in series with both the line and network windings of the hybrid transformers is provided by the LINE and NET CAP key switch, to simulate the capacitors encountered in most offices. Matched 1.08, 2.16 and 4.32 µf capacitors can be selected.

1.07 A low-pass or a high-pass filter may be inserted in the hybri output circuit with the FILTER key switch. These filters facilitate singing-point measurements when external filters are not available.

1.08 The set is entirely contained within an 8" x 11" x 7" carrying case; includes a handle and removable cover and weighs approximately 15 1/2 pounds. A front panel view is shown in Figure 1.

2.0 PERFORMANCE DATA

2.01 Networks

1- Precision Networks

H-88 Loading; Basic 1100 Ft. (.18) End-section: 19cnb, 22csa, 24dsm gage

D-88 Loading; Basic 800 Ft. (.18) End-section: 19cnb, 22csa, 24dsm gage

D-66 Loading; Basic 2250 Ft. (.5) End-section: 19cnb, 22csa, 24dsm gage

Non-loaded; 19cnb, 22csa, 24dsm gage

2- Compromise Networks

600, 900 or 1500Ω, each in series with 2.16μf.

3- 600Ω resistive termination.

2.02 Network Buildout

Two-section additive capacitance decade; 0 (open) to .11μf in .001μf steps, ±1% at any setting.

2.03 Impedances

1- 4-W IN and 4-W OUT: Balanced 600Ω nominal with line and network terminated in 600, 900 or 1500Ω; 300cps - 5000cps. DC blocked by 50μf, 75 VDC capacitors.

2- LINE and NETWORK: Balanced 600, 900 or 1500Ω nominal, with 4-wire input and output terminated in 600Ω; 300cps - 5000cps. DC blocked by matched 1.08, 2.16, or 4.32μf capacitors. Impedance vs. frequency characteristics are typical of those encountered in sets equipped with WE Type 120P coils.

2.04 Filters

See Figure 4 for response characteristics.

2.05 Transhybrid Balance

Inherent hybrid balance, with 600Ω line and network terminations matched to within ±.025% is equal to or better than:

80 db: 500 - 2500 cps
70 db: 300 - 3500 cps
60 db: 100 - 5000 cps

2.06 Transhybrid Loss

Hybrid loss from 4-W IN to 4-W OUT: Approximately 7 db
200 cps ± 5000 cps

2.07 Size

8" x 11" x 7"

2.08 Weight

15 1/2 pounds

3.0 CIRCUIT DESCRIPTION

3.01 A schematic diagram of the TN 33 is shown in Figure 3. A simplified schematic relating the basic functions of the set is shown in Figure 2.

3.02 Basic Hybrid - T1 and T2 are Type TN 44 coils connected in a conventional two-coil hybrid configuration. The LINE IMP switch, S1, selects the appropriate ratio taps on the 4-wire windings so that 600Ω is presented at the 4-W IN and 4-W OUT appearances for the corresponding line and network terminations. C-1 and C-2 provide DC blocking for the input and output respectively. The LINE and NET CAP switch, S7, selects the desired series line and network circuit capacitances through combinations of C-701, C702 and C601, C-602 respectively. In addition, S7 also selects R-3 or R-4, which, in conjunction with R-101, C-102A and C-102B, provides shunt padding across the hybrid network branch to achieve optimum transhybrid balance.

3.03 Setting the FUNCTION switch, S3 to MEASURE connects the NETWORK SELECTOR switch, S4, across the hybrid network branch. Positions 1 through 16 of S4 selects the various network configurations through appropriate strapping of CB-3, CB-4 or CB-9; position 17 selects the EXT NET terminals. The network schematics are shown in Figures 7, 8 and 9.

3.04 Two 11 position switches, S5 and S6, comprise a capacitance decade in parallel with the network selector. The decade schematics are shown in Figures 5 and 6.

3.05 With S-3 set to HYB CHECK, the hybrid line and network branches are transferred to terminating resistors R1 and R2, respectively. R1 and R2 are closely matched to achieve a high degree of transhybrid balance. With S3 set to CAL HYB LOSS, the hybrid line branch is shorted and the network branch is retained.

3.06 The FILTER switch, S2, inserts a low pass filter, located on CB-5, or a high pass filter, located on CB-8, between the hybrid and the 4-W OUT appearances. The filter schematics are shown in Figures 9 and 10 respectively.

4.0 CONTROLS, JACKS and TERMINALS

4.01 Controls

1- FUNCTION key switch: HYB CHECK, MEASURE, CAL HYB LOSS

2- LINE and NET CAP key switch: 1.08μf, 2.16μf, 4.32μf

3- LINE IMP key switch: 600Ω, 900Ω, 1500Ω

4- FILTER key switch: LOW-PASS, NONE, HIGH-PASS

5- NETWORK SELECTOR rotary switch:

H-88:	19	D-88: 19	D-66	19	600 + 2.16μf	600Ω	EXT NET
	22	22		22	900 + 2.16μf		
	24	24		24	1500 + 2.16μf		

6- BUILDOUT rotary switches: X.01μf; 0 to 10, 11 positions
X.001μf; 0 to 10, 11 positions

4.02 Jacks and Terminals

1- 4-W IN: 310 jack; 241 jacks, two insulated binding posts

2- 4-W OUT: 310 jack; 241 jacks, two insulated binding posts

3- LINE: 310 jack; 241 jacks, two insulated binding posts

4- NETWORK and BUILDOUT: two insulated binding posts

5- EXT NET: two insulated binding posts

6- CH GND: single binding post for chassis ground

7- LINE SL: single insulated binding post connected to LINE jack sleeves.

4.03 A front panel view of the Model TN 33 is shown in Figure 1.

5.0 CALIBRATION

The Model TN 33 is a passive device and as such requires no regular calibration. Critical internal adjustments are factory set for optimum balance and should not be changed in the field.

6.0 OPERATION

6.01 Return loss or singing point measurements:

1- Connect line or circuit under test and associated test equipment to the set.

2- Set the LINE IMP, LINE & NET CAP, BUILDOUT, and NETWORK SELECTOR switches for the circuit requirements.

3- Set FILTER switch to LOW PASS, NONE, or HIGH PASS, as required.

4- Perform measurements in accordance with specified test procedure.

6.02 Capacity measurements:

1- Connect oscillator and measuring set to the 4-wire IN and 4-wire OUT terminals respectively; adjust for desired frequency at a convenient level.

2- Connect circuit under test to the LINE terminals.

3- Set NETWORK SELECTOR switch to EXT NET.

4. Adjust BUILDOUT decades for highest (null)readings on measuring set. The sum of the two switch settings is the value of the unknown capacity to the nearest .001µf. If the unknown value of capacitance may be connected across the network terminals so that a null is obtained. The unknown capacity is now the sum of the decade settings and this capacitor value.

6.03 Network and buildout access for external use:

1- Set FUNCTION switch to HYB CHECK.

2- Set NETWORK SELECTOR switch to desired network.

3- Networks and buildout decades are now accessible at the NETWORK and BUILDOUT terminals.

6.04 Transhybrid balance check. The inherent hybrid coil balance may be determined in the following manner:

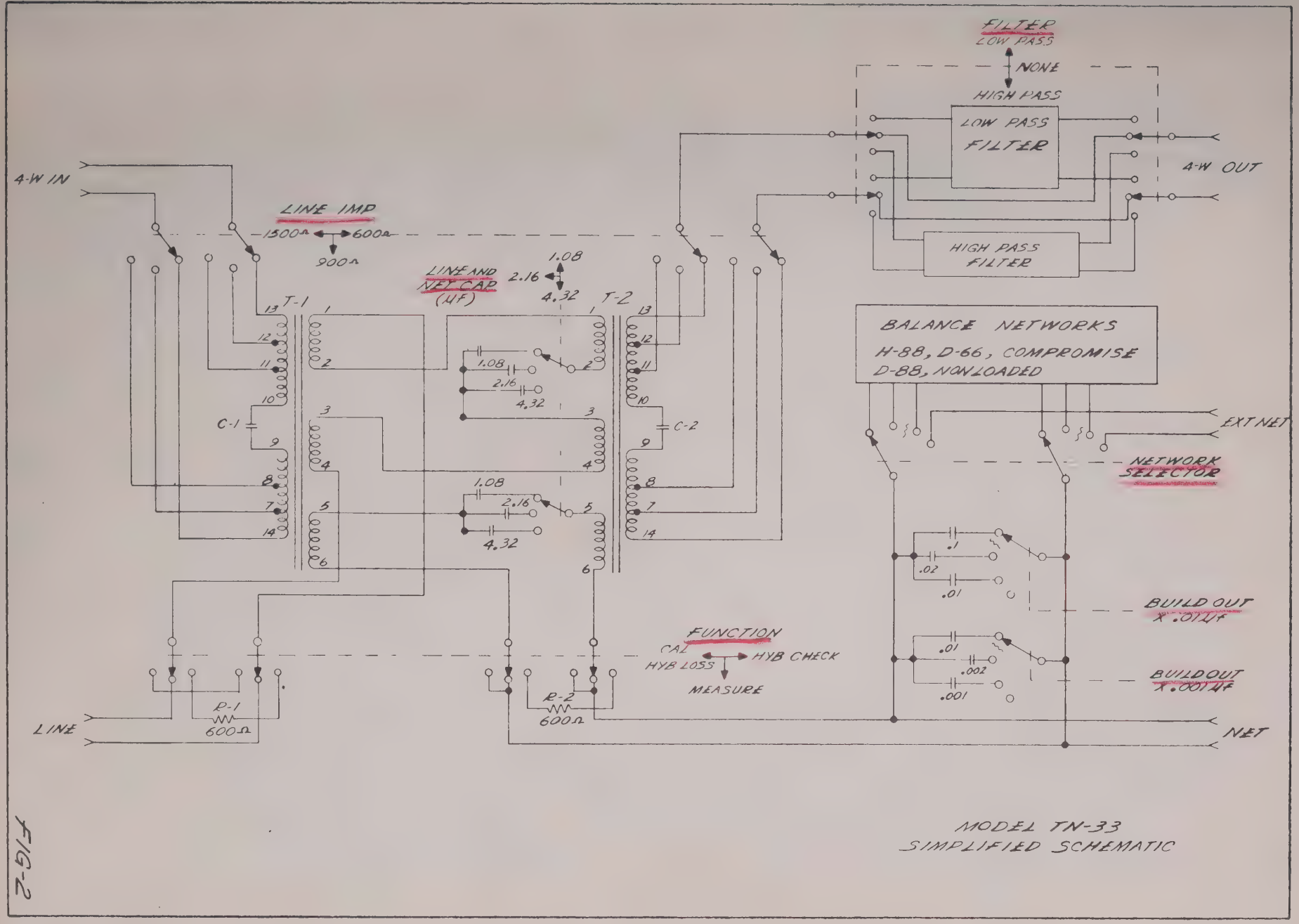
1- Set FUNCTION switch to CAL HYB LOSS and adjust oscillator for a 0 dbm reading on the measuring set, at the frequency of interest.

2- Set the FUNCTION switch to HYB CHECK and read the balance level in minus dbm on the measuring set.

7.0 MAINTENANCE

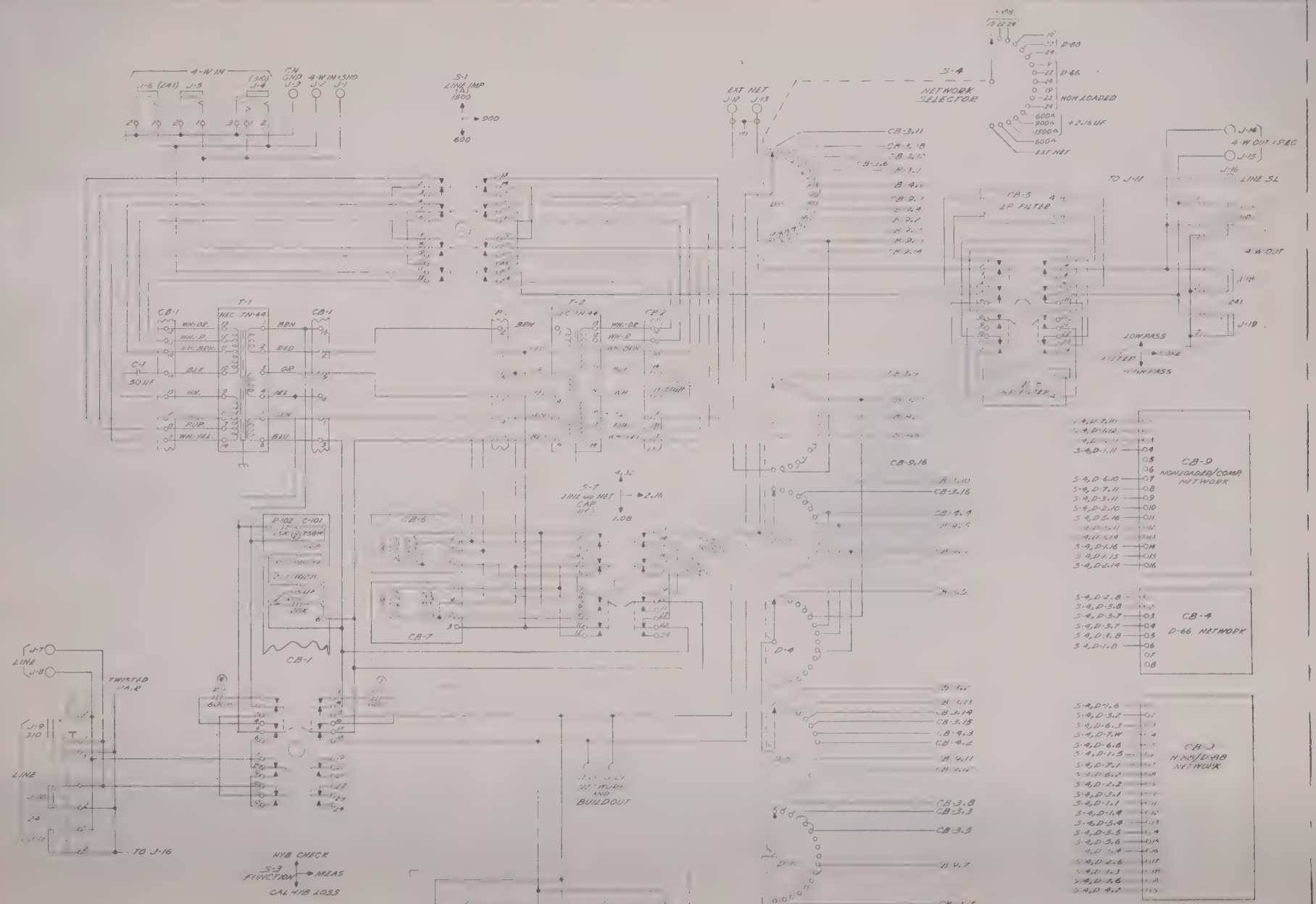
7.01 The Model TN 33 requires no routine maintenance.

7.02 If, for any reason, the set should fail to operate properly, it is recommended that it be returned to the factory for repair or adjustment.



MODEL TN-33
SIMPLIFIED SCHEMATIC

F19-2



NOTES
1. R-1, R-2 - 600Ω MATCHED TO WITHIN ± 0.025% AT 1 KC
2. EXACT VALUES OF R-3, R-4, R-101, C-102A, C-102B, C-101 & R-102 MAY VARY AS REQUIRED FOR OPTIMUM TRANS-HYBRID BALANCE CONDITIONS. TYPICAL VALUES SHOWN.

MODEL TN-33
1 of 1 HYBRID
SCHEMATIC

E-5/4

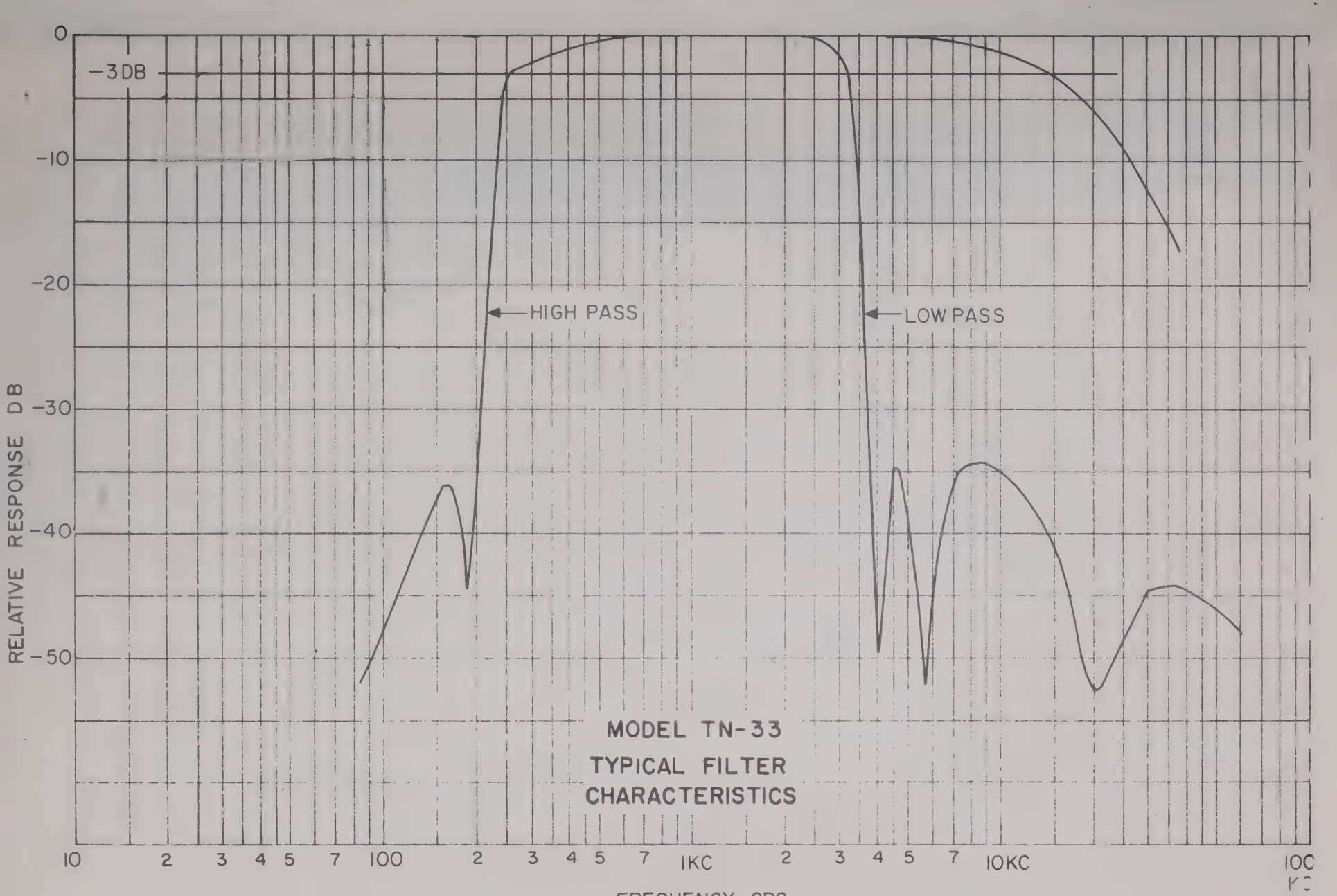
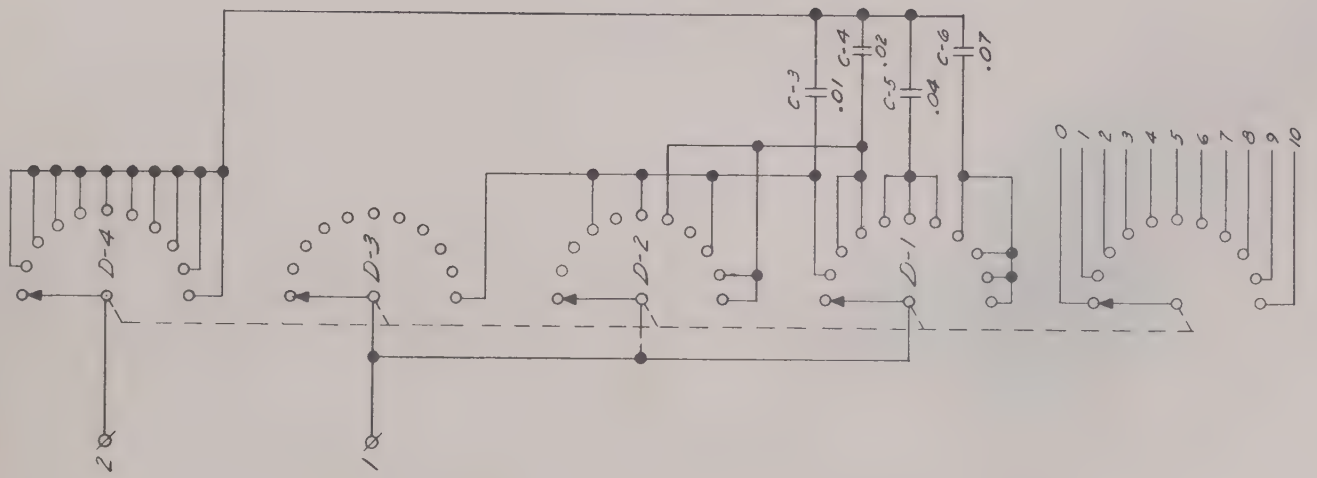

0
-3DB
-10
-20
-30
-40
-50
RELATIVE RESPONSE DB
HIGH PASS
LOW PASS
MODEL TN-33
TYPICAL FILTER
CHARACTERISTICS
10
2
3
4
5
7
100
2
3
4
5
7
1KC
2
3
4
5
7
10KC
100
FREQUENCY CPS

FIG.-4



UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON FRACTIONS ±1/64 DECIMALS ±.005 ANGLES ✓±½° ALL SURFACES	DRAWN LEO B. GAGNON DATE 11-26-65--	SCHEMATIC BUILDOUT (5-5) X.01 µf	NORTHEAST ELECTRONICS CORP. CONCORD, N. H.
MATERIAL	APPD		REF. NO. B-1233
	ISSUED		SIZE B 40981
FINISH PAINT SCREEN PER	APPROVED / DATE ENGR MFG MATL	TN-33	CONT ON SHEET SH NO
		SCALE WT CALC ACTUAL	

FIG 5-9

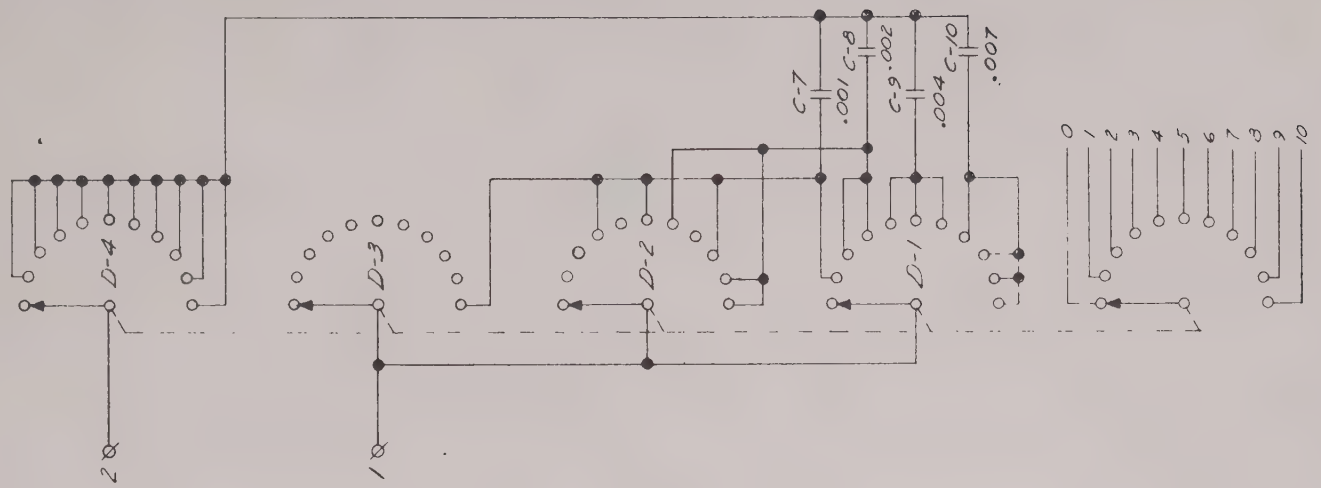
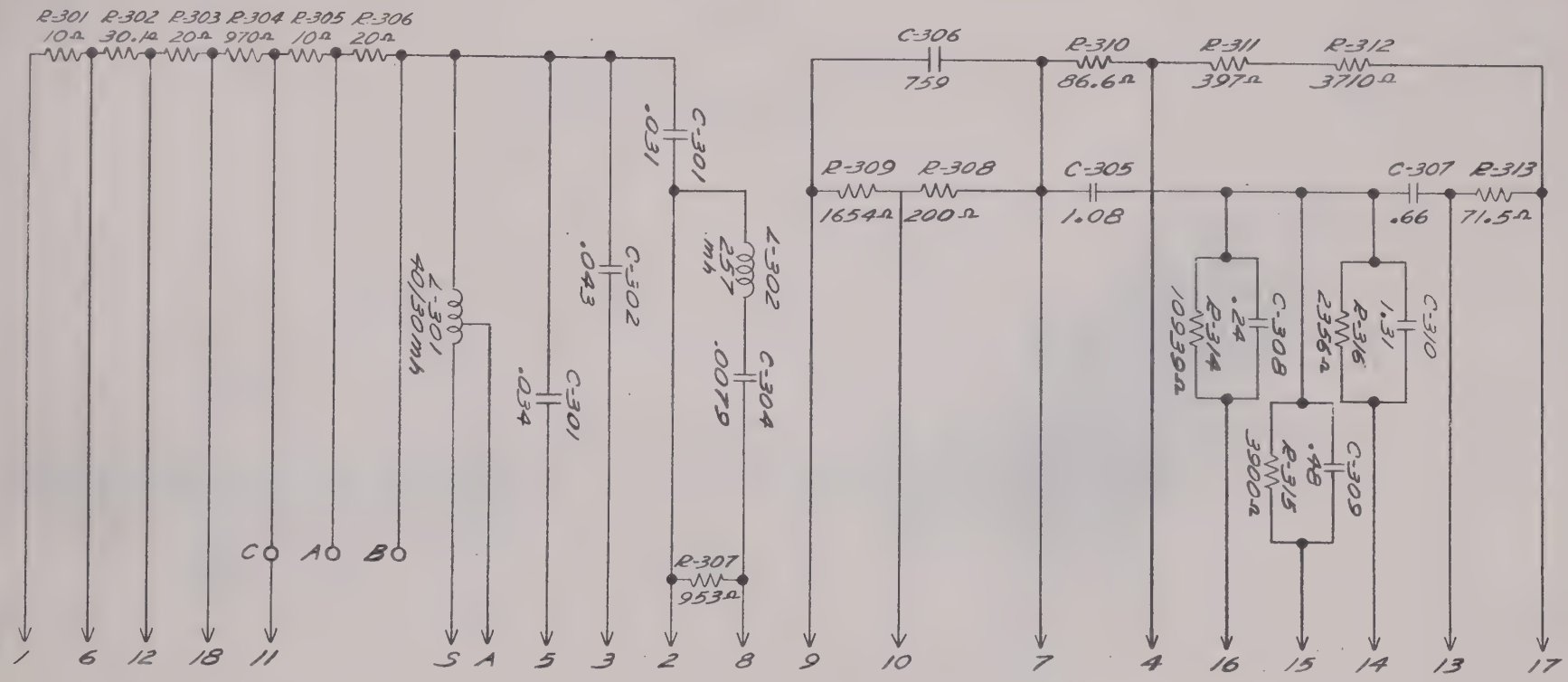


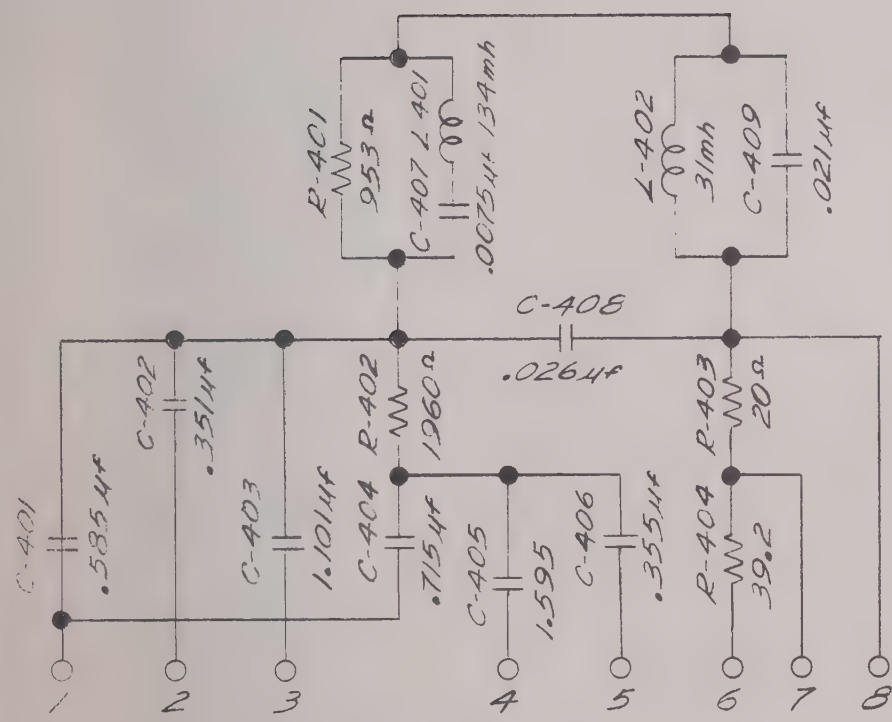
FIG-6

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON FRACTIONS ±1/64 DECIMALS ±.005 ANGLES ✓ ±½° ALL SURFACES MATERIAL FINISH PAINT SCREEN PER	DRAWN ±O B. GAGNON DATE 11-26-65 APPD ISSUED APPROVED / DATE ENGR MFG MATL	SCHEMATIC BUILDOUT (5-6) X.001 µf TN-33 SCALE WT CALC ACTUAL	NORTHEAST ELECTRONICS CORP CONCORD, N. H. REF. NO. B-1233 SIZE B 40982 CONT ON SHEET SH NO



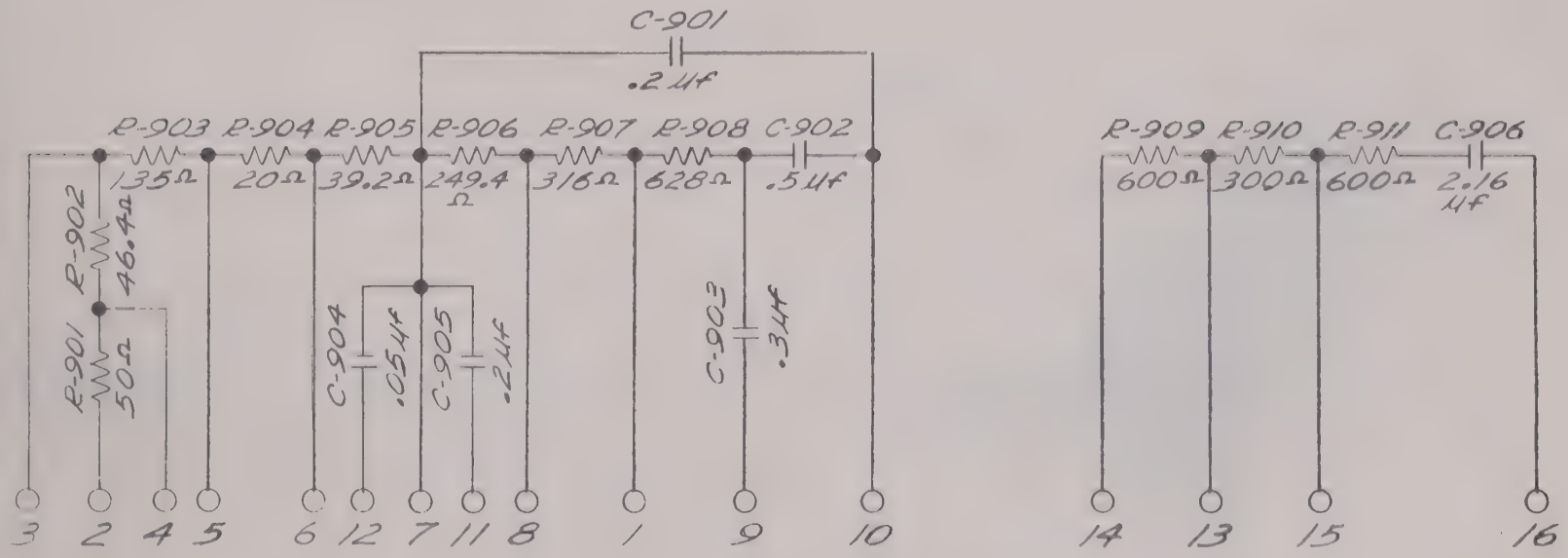
MODEL TN-33
H-88/D-88 NETWORK
SCHEMATIC

FIG-7



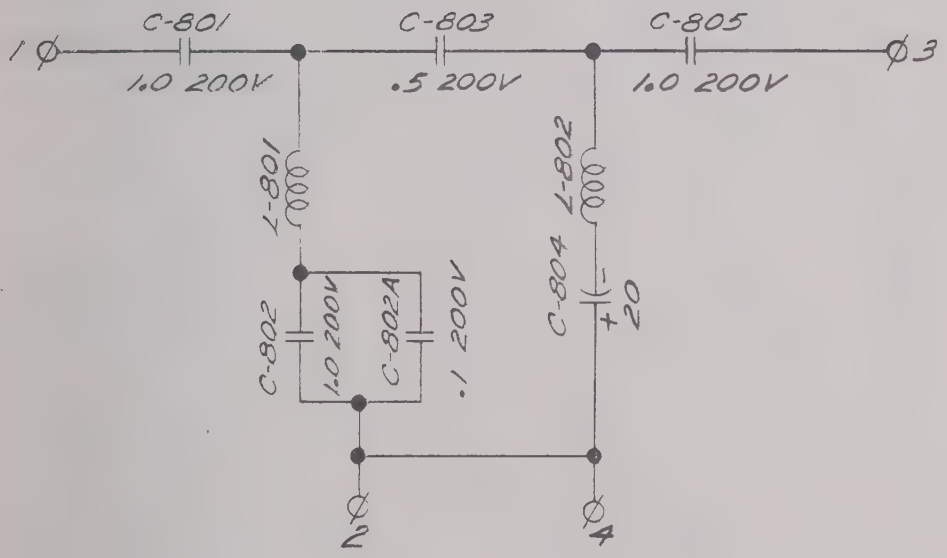
MODEL TN-33
D-66 NETWORK

FIG.-8



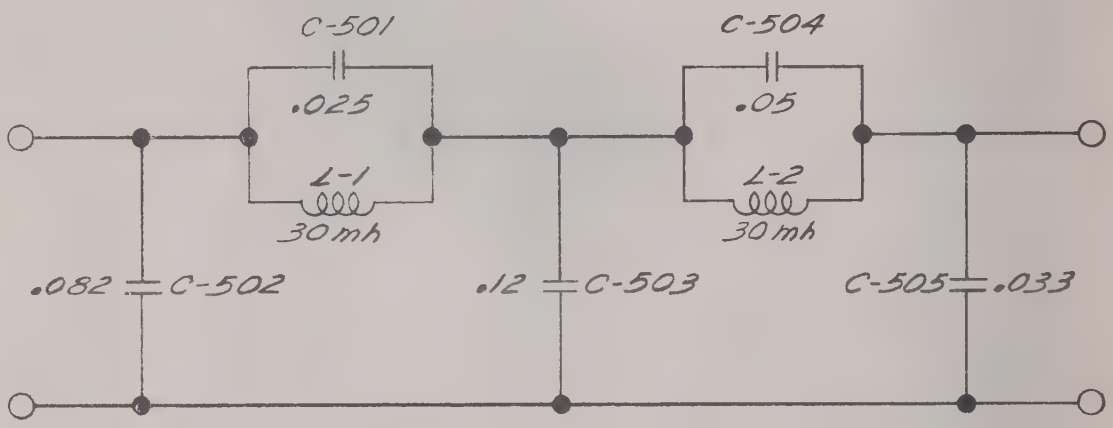
6-514

MODEL TN-33
NONLOADED/ COMP. NETWORK



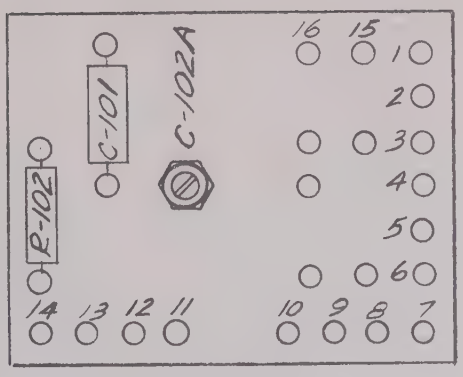
MODEL TN-33
HIGH PASS FILTER
SCHEMATIC

FIG-10

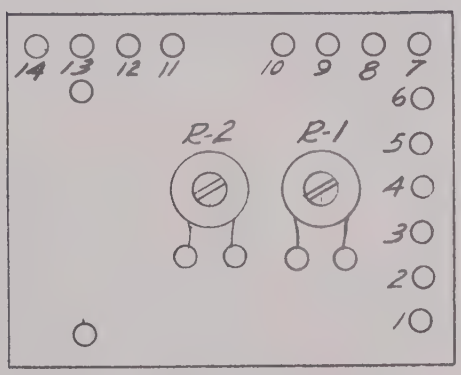


MODEL TN-33
LOW PASS FILTER
SCHEMATIC

FIG.-11



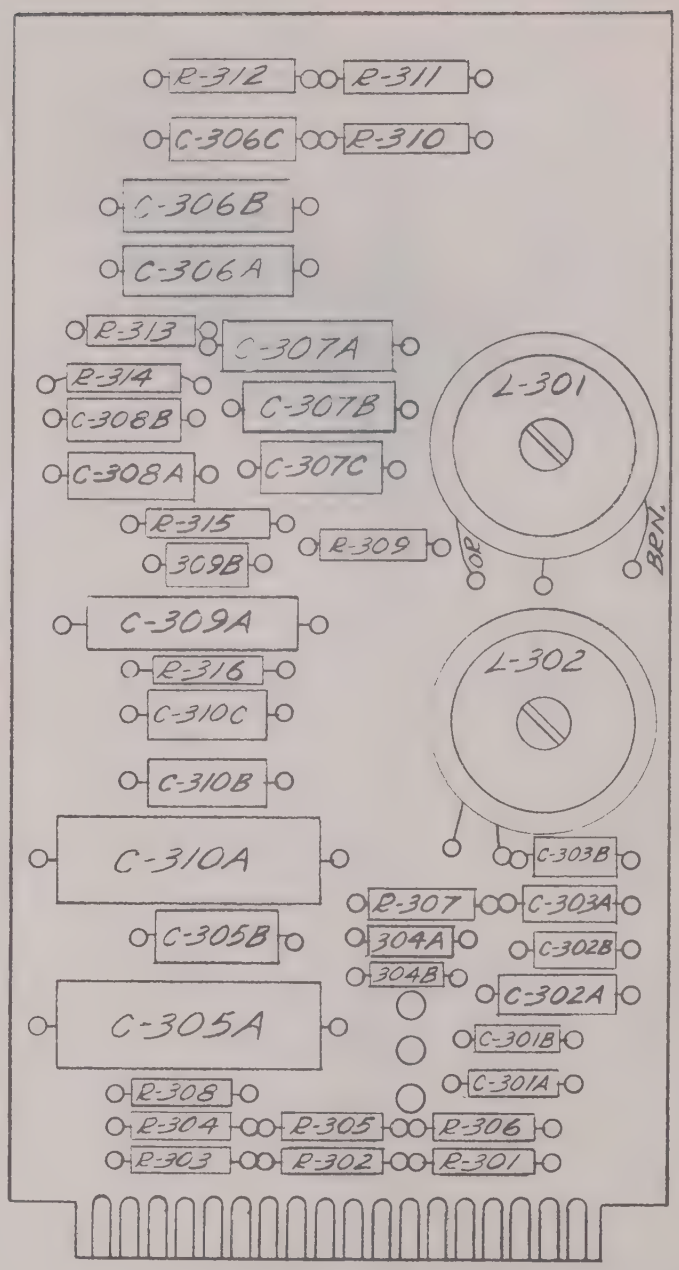
CB-1



CB-2

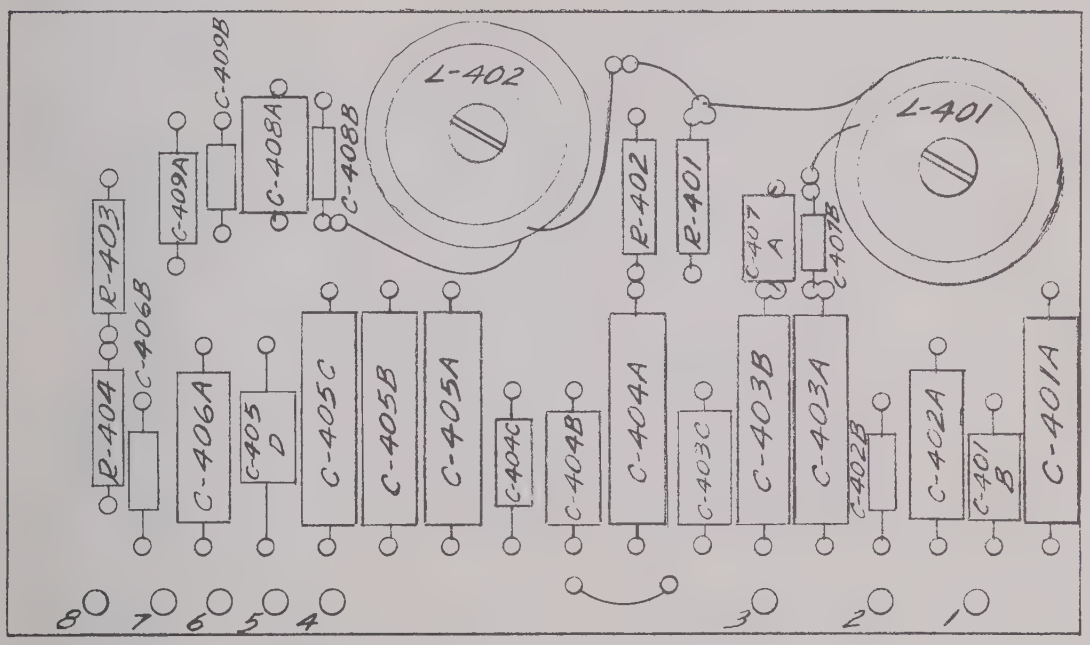
COMPONENT LAYOUT
CB-1 & CB-2
TN-33

FIG.-12



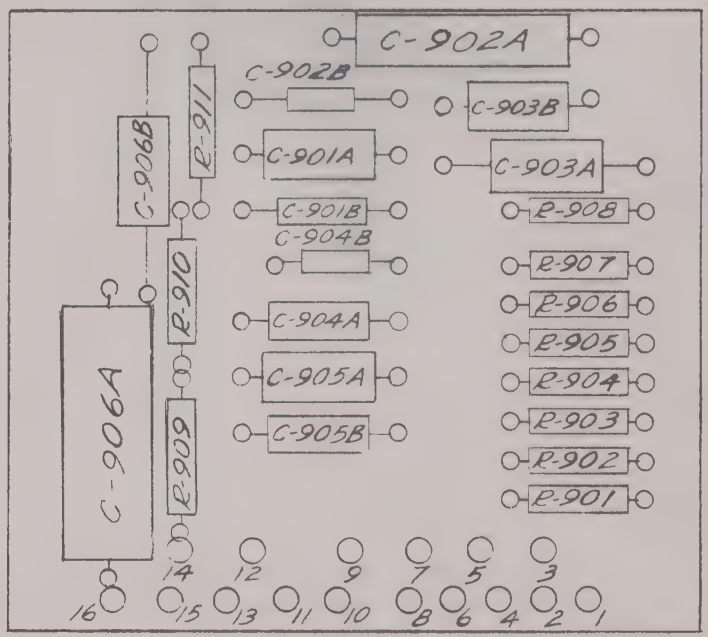
MODEL TN-33
H-88/D-88 NETWORK

FIG.- 13



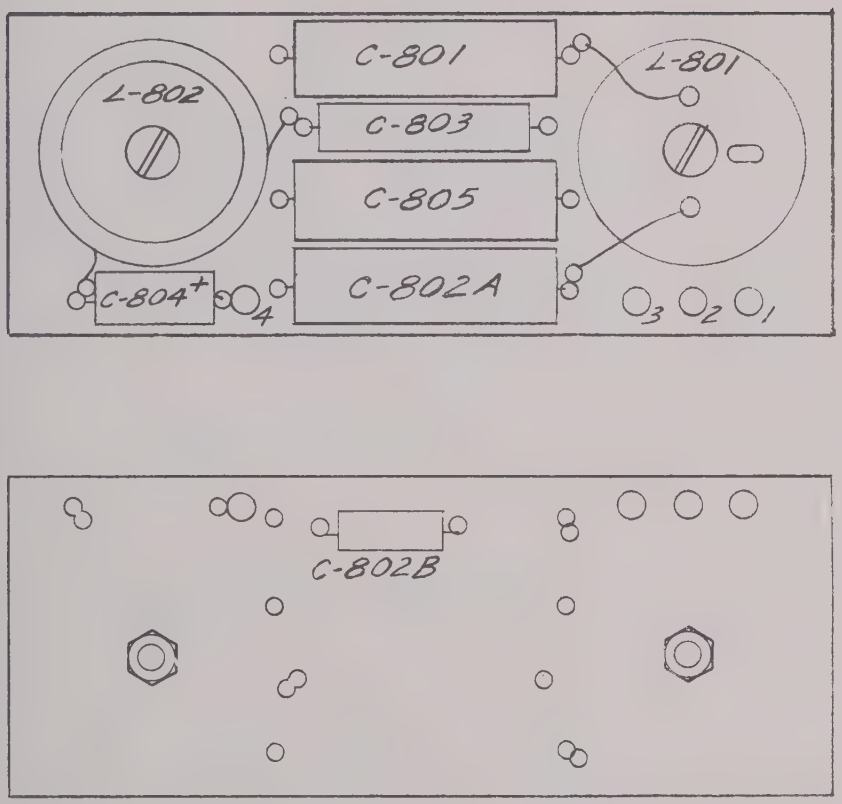
MODEL TN-33
D-66 NETWORK

FIG.- 14



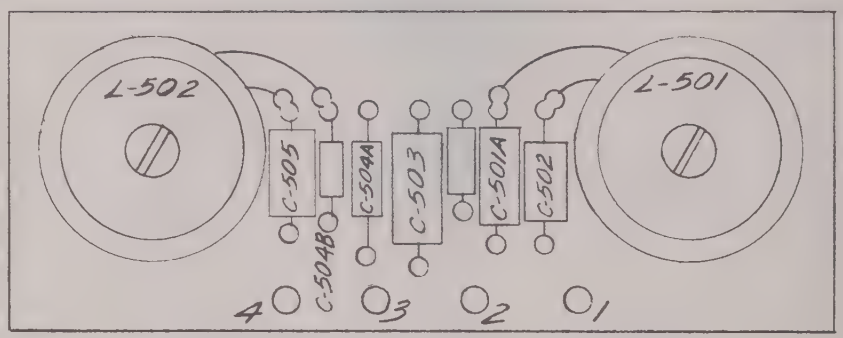
MODEL TN-33
NONLOADED / COMP. NETWORK

FIG.-15



MODEL TN-33
HIGH PASS FILTER

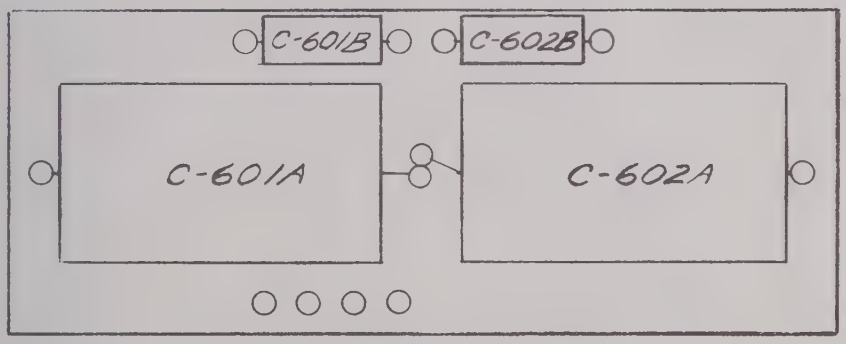
FIG:- 16

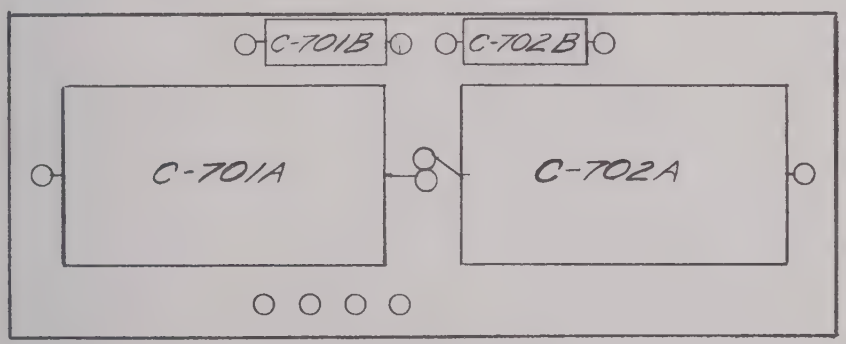


MODEL TN-33
LOW PASS FILTER

FIG.-17

CB-6





CB-7

COMPONENT LAYOUT
CB-6 + CB-7
TN-33

FIG-18

MODEL TN 33
TEST HYBRID

TABLE OF REPLACEABLE PARTS

Circuit Ref	Description	Mfr* & Mfr's Designation
C-1	Capacitor: fixed, non-polarized, 50 µf, 75VDC	H, D27359
C-2	Capacitor: fixed, non-polarized, 50 µf, 75VDC	H, D27359
C-3	Capacitor: fixed, plastic, .01 µf, ±1%, 200VDC	B, 2PJ-103F
C-4	Capacitor: fixed, plastic, .02 µf, ±1%, 200VDC	B, 2PJ-203F
C-5	Capacitor: fixed, plastic, .04 µf, ±1%, 200VDC	B, 2PJ-403F
C-6	Capacitor: fixed, plastic, .07 µf, ±1%, 200VDC	B, 2PJ-703F
C-7	Capacitor: fixed, mica, .001 µf, ±1%, 500VDC	A, 1469-102
C-8	Capacitor: fixed, mica, .002 µf, ±1%, 500VDC	A, 1464-202
C-9	Capacitor: fixed, mica, .004 µf, ±1%, 500VDC	A, 1464-402
C-10	Capacitor: fixed, mica, .007 µf, ±1%, 500VDC	A, 1464-702
C-101	Capacitor: fixed, film, selected value	
C-102A	Capacitor: variable, 350-1180 PF	A, 307
C-102B	Capacitor: fixed, film, selected value	
C-301A	Capacitor: fixed, film, .027 µf, 80VDC	H, 192P2739R8
C-301B	Capacitor: fixed, film, selected value	
C-302A	Capacitor: fixed, film, .039 µf, 80 VDC	H, 192P3939R8
C-302B	Capacitor: fixed, selected value	
C-303A	Capacitor: fixed, film, .027 µf, 80VDC	H, 192P2739R8
C-303B	Capacitor: fixed, film, selected value	
C-304A	Capacitor: fixed, film, .0068 µf, 80VDC	H, 192P6829R8
C-304B	Capacitor: fixed, film or mica, selected value	
C-305A	Capacitor: fixed, met. paper, 1 µf, 200VDC	H, 155P
C-305B	Capacitor: fixed, film, selected value	
C306A	Capacitor: fixed, film, .33 µf, 80V	H, 192P3349R8

MODEL TN 33
TEST HYBRID
TABLE OF REPLACEABLE PARTS
Page 2

Circuit Ref	Description	Mfr* & Mfr's Designation
C-306B	Capacitor: fixed, film, .33µf, 80V	H, 192P3349R8
C-306C	Capacitor: fixed, film, selected value	
C-307A	Capacitor: fixed, film, .33µf, 80VDC	H, 192P3349R8
C-307B	Capacitor: fixed, film, .27µf, 80VDC	H, 192P2749R8
C-307C	Capacitor: fixed, film, selected value	
C-308A	Capacitor: fixed, film, .22µf, 80VDC	H, 192P2249R8
C-308B	Capacitor: fixed, film, selected value	
C-309A	Capacitor: fixed, film, .39µf, 80VDC	H, 192P3949R8
C-309B	Capacitor: fixed, film, selected value	
C-310A	Capacitor: fixed, met. paper, 1.0µf, 200VDC	H, 155P
C-310B	Capacitor: fixed, film, .22µf, 80VDC	H, 192P2249R8
C-310C	Capacitor: fixed, film, selected value	
C-401A	Capacitor: fixed, film, .47µf, 80V	H, 192P4749R8
C-401B	Capacitor: fixed, film, selected value	
C-402A	Capacitor: fixed, film, .27 µf, 80VDC	H, 192P3349R8
C-402B	Capacitor: fixed, film, selected value	
C-403A	Capacitor: fixed, film, .47µf, 80VDC	H, 192P4749R8
C-403B	Capacitor: fixed, film, .47µf, 80VDC	H, 192P4749R8
C-403C	Capacitor: fixed, film, selected value	
C-404A	Capacitor: fixed, film, .47µf, 80VDC	H, 192P4749R8
C-404B	Capacitor: fixed, film, .18µf, 80VDC	H, 192P1849R8
C-404C	Capacitor: fixed, film, selected value	
C-405A	Capacitor: fixed, film, .47µf, 80VDC	H, 192P4749R8
C-405B	Capacitor: fixed, film, .47µf, 80VDC	H, 192P4749R8

MODEL TN 33
TEST HYBRID
TABLE OF REPLACEABLE PARTS
Page 3

Circuit Ref	Description	Mfr* & Mfr's Designation
C-405C	Capacitor: fixed, film, 47µf, 80VDC	H, 192P4749R8
C-405D	Capacitor: fixed, selected value	
C-406A	Capacitor: fixed, film, .27µf, 80VDC	H, 192P3349R8
C-406B	Capacitor: fixed, film, selected value	
C-407A	Capacitor: fixed, film, .0068µf, 80VDC	H, 192P6829R8
C-407B	Capacitor: fixed, film or mica, selected value	
C-408A	Capacitor: fixed, film, .022µf, 80VDC	H, 192P2239R8
C-408B	Capacitor: fixed, film, selected value	
C-309A	Capacitor: fixed, film, .018µf, 80VDC	H, 192P1839R8
C-409B	Capacitor: fixed, film or mica, selected value	
C-501A	Capacitor: fixed, film, .022µf, 80VDC	H, 192P2239R8
C-501B	Capacitor: fixed, film, selected value	
C-502	Capacitor: fixed, film, .082µf, 80VDC	H, 192P8239R8
C-503	Capacitor: fixed, film, .12µf, 80VDC	H, 192P1249R8
C-504A	Capacitor: fixed, film, .047µf, 80VDC	H, 192P4739R8
C-504B	Capacitor: fixed, film, selected value	
C-505	Capacitor: fixed, film, .033µf, 80VDC	H, 192P3339R8
C-601A	Capacitor: fixed, met. paper, 2µf, 400VDC	H, 121P20591RS4
C-601B	Capacitor: fixed, paper, selected value	
C-602A	Capacitor: fixed, met. paper, 2µf, 400VDC	H, 121P20591RS4
C-602B	Capacitor: fixed, paper, selected value	
C-701A	Capacitor: fixed, met. paper, 2µf, 400VDC	H, 121P20591RS4
C-701B	Capacitor: fixed, paper, selected value, 400VDC	
C-702A	Capacitor: fixed, met. paper, 2µf, 400VDC	H, 121P20591RS4

MODEL TN 33
TEST HYBRID
TABLE OF REPLACEABLE PARTS
Page 4

Circuit Ref	Description	Mfr* & Mfr's Designation
C-702B	Capacitor: fixed, paper, selected value, 400VDC	
C-801	Capacitor: fixed, met. paper, 1.0µf, 200VDC	H, 155P
C-802A	Capacitor: fixed, met. paper, 1.0µf, 200VDC	H, 155P
C-802B	Capacitor: fixed, film, .1uf, 80VDC	H, 192P1049R8
C-803	Capacitor: fixed, film, .5uf, 80VDC	H, 192P5049R8
C-804	Capacitor: fixed, electrolytic, 20µf, 25VDC	P, ADP-046
C-805	Capacitor: fixed, met. paper, 1.0µf, 200VDC	H, 155P
C-901A	Capacitor: fixed, film, .18µf, 80VDC	H, 192P1849R8
C-901B	Capacitor: fixed, film, selected value	
C-902A	Capacitor: fixed, film, .47µf, 80VDC	H, 192P4749R8
C-902B	Capacitor: fixed, film, selected value	
C-903A	Capacitor: fixed, film, .27µf, 80VDC	H, 192P2749R8
C-903B	Capacitor: fixed, film, selected value	
C-904A	Capacitor: fixed, film, .039µf, 80VDC	H, 192P3939R8
C-904B	Capacitor: fixed, film, selected value	
C-905A	Capacitor: fixed, film, .18µf, 80VDC	H, 192P1849R8
C-905B	Capacitor: fixed, film, selected value	
C-906A	Capacitor: fixed, met. paper, 2.0µf, 150VDC	H, 121P 20591R5S4
C-906B	Capacitor: fixed, film, selected value	
R-1	Resistor: fixed, wirewound, 600Ω, ±1%, 1/2w	K, CR-35
R-2	Resistor: fixed, wirewound, 600Ω, ±1%, 1/2w (R-1 and R-2 are matched set)	K, CR-35
R-3	Resistor: fixed, metal film, selected value	F, CEC-TO
R-4	Resistor: fixed, metal film, selected value	F, CEC-TO

MODEL TN 33
TEST HYBRID
TABLE OF REPLACEABLE PARTS
Page 5

Circuit Ref	Description	Mfr* & Mfr's Designation
R-101	Resistor: fixed, metal film, selected value	F, CEC-TO
R-102	Resistor: fixed, metal film, selected value	F, CEC-TO
R-301	Resistor: fixed, metal film, 10.0Ω ±1%, 1/2w	F, CEC-TO
R-302	Resistor: fixed, metal film, 30.1Ω ±1%, 1/2w	F, CEC-TO
R-303	Resistor: fixed, metal film, 20.0Ω ±1%, 1/2w	F, CEC-TO
R-304	Resistor: fixed, metal film, 970Ω ±1%, 1/2w	F, CEC-TO
R-305	Resistor: fixed, metal film, 10Ω ±1%, 1/2w	F, CEC-TO
R-306	Resistor: fixed, metal film, 20Ω ±1%, 1/2w	F, CEC-TO
R-307	Resistor: fixed, metal film, 953Ω ±1%, 1/2w	F, CEC-TO
R-308	Resistor: fixed, metal film, 200Ω ±1%, 1/2w	F, CEC-TO
R-309	Resistor: fixed, metal film, 1654Ω ±1%, 1/2w	F, CEC-TO
R-310	Resistor: fixed, metal film, 86.6Ω ±1%, 1/2w	F, CEC-TO
R-311	Resistor: fixed, metal film, 397Ω ±1%, 1/2w	F, CEC-TO
R-312	Resistor: fixed, metal film, 371Ω ±1%, 1/2w	F, CEC-TO
R-314	Resistor: fixed, metal film, 11,300Ω ±1% 1/2w	F, CEC-TO
R-315	Resistor: fixed, metal film, 3900Ω ±1%, 1/2w	F, CEC-TO
R-316	Resistor: fixed, metal film, 2370Ω ±1% 1/2w	F, CEC-TO

MODEL TN 33
TEST HYBRID
TABLE OF REPLACEABLE PARTS

Circuit Ref	Designation	Mfr* & Mfr's Designation
R-401	Resistor: fixed, metal film, 953Ω, ±1%, 1/2w	F, CEC-TO
R-402	Resistor: fixed, metal film, 1960Ω, ±1%, 1/2w	F, CEC-TO
R-403	Resistor: fixed, metal film, 20.0Ω, ±1%, 1/2w	F, CEC-TO
R-404	Resistor: fixed, metal film, 39.2Ω, ±1%, 1/2w	F, CEC-TO
R-901	Resistor: fixed, metal film, 50.0Ω, ±1%, 1/2w	F, CEC-TO
R-902	Resistor: fixed, metal film, 46.4Ω, ±1%, 1/2w	F, CEC-TO
R-903	Resistor: fixed, metal film, 135Ω, ±1%, 1/2w	F, CEC-TO
R-904	Resistor: fixed, metal film, 20.0Ω, ±1%, 1/2w	F, CEC-TO
R-905	Resistor: fixed, metal film, 39.2Ω, ±1%, 1/2w	F, CEC-TO
R-906	Resistor: fixed, metal film, 249.4Ω, ±1%, 1/2w	F, CEC-TO
R-907	Resistor: fixed, metal film, 316Ω, ±1%, 1/2w	F, CEC-TO
R-908	Resistor: fixed, metal film, 628Ω, ±1%, 1/2w	F, CEC-TO
R-909	Resistor: fixed, metal film, 600Ω, ±1%, 1/2w	F, CEC-TO
R-910	Resistor: fixed, metal film, 300Ω, ±1%, 1/2w	F, CEC-TO
R-911	Resistor: fixed, metal film, 600Ω, ±1%, 1/2w	F, CEC-TO
L-301	Inductor: toroidal, 30.0/40.0 mh, ±1%	NEC, 030-040-4
L-302	Inductor: toroidal, 257.2 mh, ±1%	NEC, 2572-81

MODEL TN 33
TEST HYBRID
TABLE OF REPLACEABLE PARTS

Circuit Ref	Description	Mfr* & Mfr's Designation
L-401	Industor: toroidal, 134 mh, ±1%	NEC, 134-10
L-402	Inductor: toroidal, 31.0 mh, ±1%	NEC, 031-5
L-501	Inductor: toroidal, 30.0 mh, ±1%	L, EC-030
L-502	Inductor: toroidal, 30.0 mh, ±1%	L, EC-030
L-801	Inductor: toroidal, 720 mh, ±1%	M, ET-403-1470-7
L-802	Inductor: toroidal, 250 mh, ±1%	L, EC-250
T-1	Transformer: hybrid	NEC - TN 44
T-2	Transformer: hybrid	NEC - TN 44
S-1	Switch: key, telephone, 3 position (LINE IMP)	I, 173P
S-2	Switch: key, telephone, 3 position (FILTER)	I, 173P
S-3	Switch: key, telephone, 3 position, (FUNCTION)	I, 173P
S-4	Switch: rotary, 17 position, 7 pole, (NET SEL)	G, 253-736-DL7
S-5	Switch: rotary, 11 position, 4 pole, (BUILDOUT X.01uf)	C, PA-1015
S-6	Switch: rotary, 11 position, 4 pole, (BUILDOUT X.001uf)	C, PA-1015
S-7	Switch: key, telephone 3 position, (LINE&NET CAP)	I, 173P
	Knob for S-4	D, 265
	Knobs for S-5 and S-6 (2 per set)	N, 2250
J-1	Binding Post: black (IN)	E, 29-1B
J-2	Binding Post: black (IN)	E, 29-1B
J-3	Binding Post: black (CH GND)	E, 29-1B
J-4	Jack: telephone, 310 type (IN)	J, 5J-11329

MODEL TN 33
TEST HYBRID
TABLE OF REPLACEABLE PARTS

Circuit Ref	Description	Mfr* & Mfr's Designation
J-5	Jack: telephone, 241 type (IN)	J, 5J-1194
J-6	Jack: telephone, 241 type (IN)	J, 5J-1194
J-7	Binding Post: black (LINE)	E, 29-1B
J-8	Binding Post: black (LINE)	E, 29-1B
J-9	Jack: telephone, 310 type (LINE)	J, 5J-1329
J-10	Jack: telephone, 241 type (LINE)	J, 5J-1194
J-11	Jack: telephone, 241 type (LINE)	J, 5J-1194
J-12	Binding Post: black (EXT NET)	E, 29-1B
J-13	Binding Post: black (EXT NET)	E, 29-1B
J-14	Binding Post: black (OUT)	E, 29-1B
J-15	Binding Post: black (OUT)	E, 29-1B
J-16	Binding Post: black (LINE SL)	E, 29-1B
J-17	Jack: telephone, 310 type (OUT)	J, 5J-1329
J-18	Jack: telephone, 241 type (OUT)	J, 5J-1194
J-19	Jack: telephone, 241 type (OUT)	J, 5J-1194
J-20	Binding Post: black (NETWORK)	E, 29-1B
J-21	Binding Post: black (NETWORK)	E, 29-1B

*See "List of Manufacturers Code Letters for Replaceable Parts Table"

MODEL TN 33
TEST HYBRID

LIST OF MANUFACTURERS CODE LETTERS FOR REPLACEABLE PARTS TABLE

Code Letter	Manufacturer
A	Aerovox Corporation
B	Arco Electronics, Inc.
C	Centralab
D	Dimco-Gray
E	Grayhill
F	International Resistance Co.
G	Oak Manufacturing Company
H	Sprague Electric Company
I	Stromberg-Carlson Company
J	Switchcraft, Inc.
K	Tel-Labs, Inc.
L	Triad Transformer Corp.
M	Sangamo Electric Company
NEC	Northeast Electronics Corp.
O	H.H. Smith Company
P	International Electronic Industries